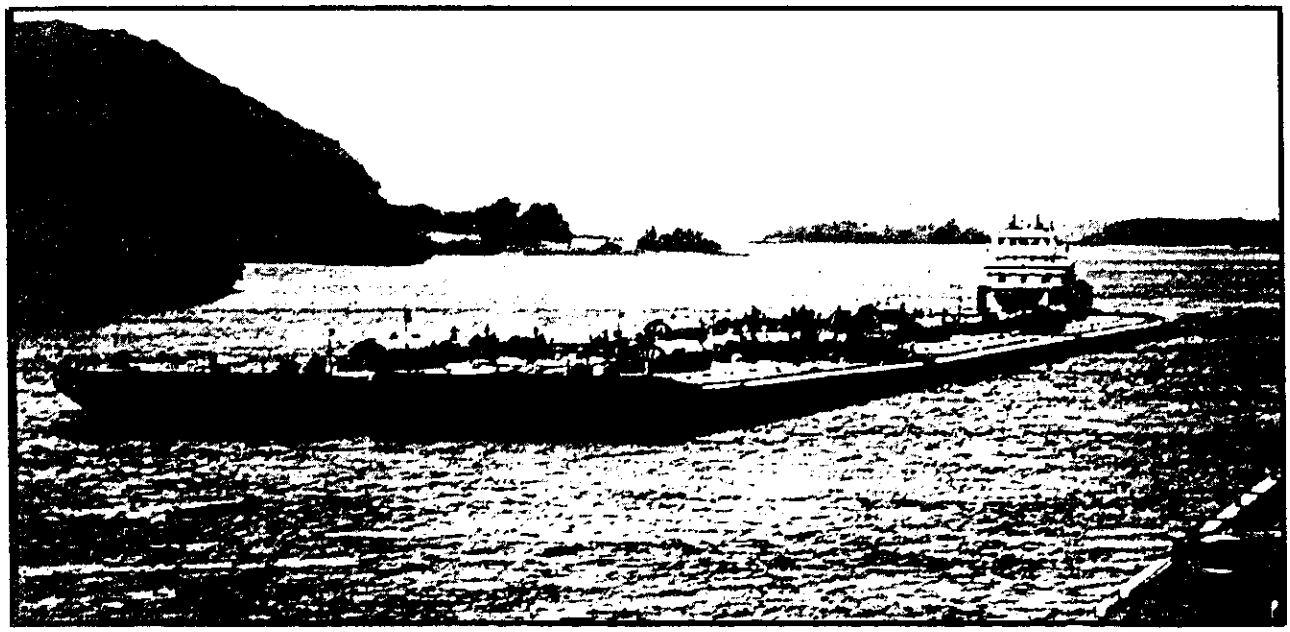
U.S. Department
of Transportation

Maritime
Administration

Environmental Advantages of Inland Barge Transportation

August 1994



Final Report

Environmental Advantages of Inland Barge Transportation

Final Report

August 1994

Prepared by the Office of Market Promotion

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

The Maritime Administration would like to express its appreciation to the members of the Advisory Committee and acknowledge their contribution to this report. These experts provided valuable advice, suggestions, and review of various material used in preparing this report.

Advisory Committee

Paul J. Werner
American Waterways Operators,Inc.
St. Louis, Missouri

W. R. Coles
W. R. Coles & Associates
Nashville, Tennessee

M. W. Newstrand
Minnesota Department
of Transportation
St. Paul, Minnesota

Robert H. Hertzberg
Upper Mississippi
Waterway Association
St. Paul, Minnesota

INTRODUCTION

Transportation has substantially shaped the growth and development of the United States. To sustain and enhance that economic vitality and growth, and the productivity of commerce, the nation needs a healthy and responsive transportation system. Consequently, it has been the policy of the United States to make investments that will allow its transportation system to be the engine of tomorrow's growth and prosperity, and to take full advantage of new and emerging transportation technologies. At the same time, the nation has followed a policy of ensuring that its transportation system supports safety, security, conservation of energy and environmental quality.

The strength of a transportation system lies in its diversity, with each mode having its own system-specific advantages: motor carriers have the ability to provide door-to-door service; water carriers can handle bulk commodities safely at very low cost; and rails can transport a broad range of commodities over long distances. The public good is best served by the most efficient use of transport resources, regardless of mode. However, in today's intermodal systems, we have a cooperative climate because this type of 'an operation requires the coordination of more than one mode. This efficiency and competitiveness of different transportation systems is essential to both economic growth and productivity, and ensures that the United States will be competitive in the world market.

Efficient freight transportation systems play a positive role both in the economic life of industrialized countries and the daily lives of their citizens. These countries realize the importance of the relationship between good systems and services and their economy. However, while these transportation systems are essential to a modern society, and there are substantial economic benefits to be realized from them, there are also significant negative environmental impacts, including preemption of land, disruption of topography, use of energy and other resources, and noise and air pollution. More and more, public concern is focusing on these negative impacts. When decisions are being made concerning a choice of modes, consideration should be given to the mode that does not contribute to unnecessary increases in fuel use, exhaust emissions, accidents, spill incidents, and congestion.

The result of this concern over the impact of transportation systems on the environment is reflected in how those systems are now being planned for the future. Transportation designers and environmentalists, both of whom recognize the interdependence between transportation systems and the environment, are

increasingly concerned about maintaining an appropriate balance between the two -- and environmental laws have now established a legal framework aimed at keeping transportation decisions consistent with that goal.

It seems that not a day goes by without some new evidence of the increasing pollution of our environment and its consequences. There are indications everywhere that environmental rights (breathable air, drinkable water, fertile soil), which have been regarded as inexhaustible or renewable, are becoming scarce.

Today, with much more environmental awareness and a greater understanding of the consequences of pollution, both government and society are much less tolerant of pollution.

On a global scale, pollution is a growing threat to both human health and the environment. Commercial freight transportation, with its almost total dependence on petroleum-based fuels, contributes significantly to pollution levels. Therefore, each form of transportation, as a major energy user, needs to be evaluated both as to the scarceness and future availability of the energy resources that it uses and to its impact on the environment.

With each transport mode having its own specific energy-use and environmental characteristics, decisions on transport issues, whether short or long term, have inevitable impacts on the environment, which should be clearly weighed before a final decision is made.

Both the environment and the quality of life are receiving greater attention, resulting in a growing demand for not only an environmentally sound transportation system, but also for policies where environmental goals are given greater weight in transportation decisions.

ENERGY EFFICIENCY

The concepts of relative energy efficiency, or energy intensity as it is often called, are used to measure the amount of service that results from each unit of energy expended in the process. Energy intensiveness for freight carriage is the number of BTUs required to move one ton of cargo one mile, with energy efficiency the inverse of energy intensiveness. While these concepts are useful, exact comparisons are not always possible due to varying situations. (For example, a study by the Minnesota Department of Transportation showed that, while towboats operating on the Lower Mississippi River can move as much as **1,200** freight ton-miles per gallon of fuel, further upriver, **514** ton-miles is a more representative figure). Nevertheless, these concepts provide a fairly accurate indication of different aspects of energy consumption.

Energy efficiency is usually measured in one of two ways: by comparing how many miles each mode of transportation can carry a ton of freight per gallon of fuel, or by how many BTUs are expended per ton mile.

Numerous studies of fuel efficiency have been done, including some sponsored by the United States Departments of Energy and Transportation, and practically every one of these studies show similar results; viz. that shallow-draft water transportation is the most fuel efficient mode of transportation for moving bulk raw materials, is the least energy intensive method of freight transportation when moving equivalent amounts of cargo, and consumes less energy than alternative modes. Of these studies, two of the most comprehensive and informative have been done by the U.S. Congressional Budget Office (CBO) and S.E. Eastman.

The major finding of the CBO study was that, in terms of energy efficiency for different modes of transportation, inland barges were the most efficient:

MEASURES OF FREIGHT ENERGY EFFICIENCY (in) BTUs per net ton-mile

Mode		Operating Energy a/	Line-Haul Energy b/	Modal Energy c/
Rail -	Overall	660	1,130	1,720
Unit	Coal Train	370	590	890
Truck -	Average Intercity	2,100	2,800	3,420
Barge -	Overall	420	540	990
	Upstream	580	700	1,280
	Downstream	220	340	620

NOTE: Net ton-miles includes weight of carqo onlv, excluding carrying unit(s):

a/ Propulsion energy including refinery losses.
b/ Combines operating energy with maintenance energy, vehicle manufacturing energy, and construction energy.
c/ Adjusts line-haul energy for circuitry.

SOURCE: CONGRESSIONAL BUDGET OFFICE, U.S. CONGRESS, ***ENERGY USE IN FREIGHT TRANSPORTATION,*** WASHINGTON, DC, FEBRUARY 1982, pp. 10.

The Eastman study found "barge transportation to be the most fuel efficient method of moving the raw materials and semi-finished products needed by the nation's economy." Data for average barge energy intensiveness showed a range of between 270 BTUs and 350 BTUs per ton-mile, well below the range of 650 BTUs to 750 BTUs per ton-mile for rail. 1/

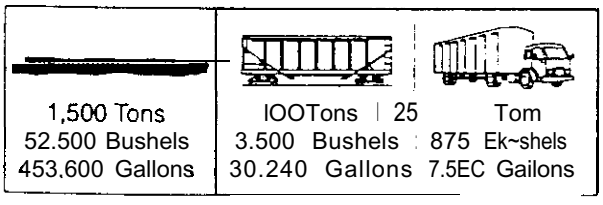
A study done by the RAND Corporation determined that, on the average, water carriers consume 500 BTUs of energy per ton-mile, the lowest of any mode. 2/ Rail was next lowest, with 750 BTUs per ton-mile, and trucks with 2,400 BTUs per ton-mile. Converting these numbers from BTUs to gallons shows that water carriers burn about 3.6 gallons of fuel per 1,000 ton-miles of cargo moved. In other studies, individual water carriers reported consumption rates of 2.92 and 2.99 gallons on the same basis, which would indicate that water carriers require approximately 410 BTUs to move a ton-mile of freight -- even lower than the Rand findinqs and more in line with the Eastman study.

An analysis of 12 different studies of rail and water efficiency shows that the average BTU expended per revenue ton-mile is 433 for water transport and 696 for rail transport. 3/

In terms of capacity, a 1,500-ton barge carries as much as fifteen loo-ton jumbo hopper rail cars or sixty 25-ton trailer trucks (see Fig. 1). A standard barge is 195 feet long; the fifteen rail cars would be 825 feet long; and the sixty trucks would be over a half mile long. A typical size barge tow consists of fifteen barges that has a capacity of 22,500 tons and is approximately one-quarter mile in length. The equivalent capacity of the other modes would be two hundred twenty-five rail cars measuring two and three-quarters miles long, and nine hundred 25-ton trailer trucks stretching 36 miles -- assuming 150 feet between trucks. To move this 22,500 tons one mile would take 44 gallons of diesel fuel by water, 111 gallons by rail, and 381 gallons by truck.

FIG. 1

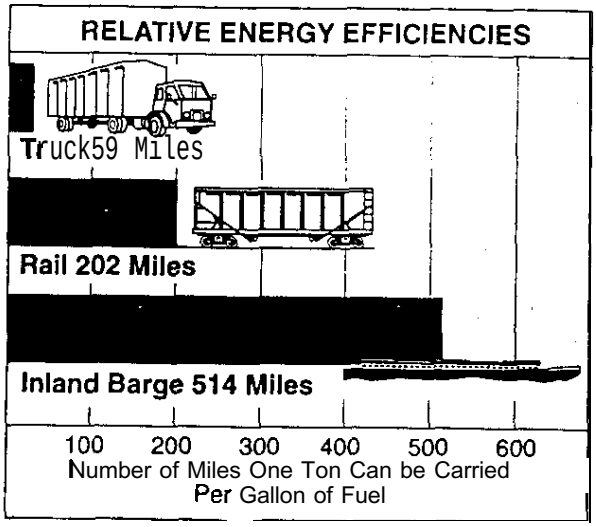
CARGO CAPACITIES



Most studies have concluded that water transportation is more economical in its use of energy per ton-mile transported than either rail or truck, consuming significantly less fuel to do the same job. The energy cost per ton mile for truck is at least four times greater than rail, and five times greater than water transport. While inland water transport requires 3.15 gallons of fuel per one thousand ton-miles of freight, rail freight requires 4.21 gallons, or 33 percent more that barges, and truck freight requires 8.33 gallons or 164 percent more than barges. 4/

The Eastman study shows that the distance one gallon of fuel can move one ton is 59 miles by truck, 202 miles by train, and 514 miles by water (See Fig. 2).

FIG. 2



This modal comparison of fuel consumption on a ton-mile per gallon basis reveals that a semitrailer on the highway carries somewhat less than 300 pounds per horsepower; a 175-car trainload of iron ore carries about 4,500 pounds per horsepower; and a 5,600 horsepower towboat is capable of propelling some 30,000 tons of cargo, which is equivalent to about 10,700 pounds per horsepower. 5/

In considering the choice of alternative transportation modes, one question that should be addressed is whether cargo that is shifted from one mode to another will result in greater energy consumption by the less fuel-efficient mode? This is a natural concern in view of the fact that, in 1991, the commercial freight transportation sector (rail and water only) accounted for 32.5 billion gallons of distillate and residual fuel oil sold in the U.S., a level of consumption that is likely to grow due to an increasing use by this sector.

It is important to note that the energy efficiency of barge transportation results in other environmental benefits besides the obvious fuel savings. As a consequence of being less energy intensive than other modes, on a ton-mile basis water transport also produces less air pollution, -- and is usually quieter. The less energy used, the less air pollution produced.

With the nation's conservation goals being driven by both energy efficiency and environmental concerns, and the future of transportation closely linked to the future of world energy, policies involving both energy and environmental goals should not be developed in isolation. The use of energy by the different modes of freight transportation has become of increasing concern in setting transportation policy. For commercial freight transporters, therefore, conserving energy and concern for the environment are factors that are interrelated.

As consumers of energy in the United States, the commercial transportation sector is almost totally dependent on petroleum fuels. In 1991, 65 percent of all petroleum products in the form of distillate and residual fuel oil, was consumed in this country by the commercial freight transportation sector. Consequently, it has a vested interest in conserving energy resources while minimizing environmental problems resulting from its use of petroleum.

SAFETY

Transporting freight in today's environmental climate means accepting the responsibility to transport it safely, and water transport has the fewest numbers of incidents, fatalities, and injuries of any surface mode.

The inland water transportation environment, with its slow transit speeds, is relatively mild, and shock and vibration levels, which are dampened out by the cushioning effect of the waterway itself, are not normally considered a problem.

The commodities on which our lives and livelihood depend have to be transported by one mode or another, and shallow-draft water transportation offers definite advantages. One is that water transport is significantly safer. Highway trucking is intermixed in traffic with automobiles and, in urban areas, with pedestrians. Rail cars are susceptible to accidents, often times resulting in a loss of cargo, because rail shipments typically involve a large number of massive units traveling at high speed in a single line. If an accident occurs, the result is often a multiple collision involving a number of rail cars of sizable mass and speed causing severe damage. River barges, however, share their right-of-way mostly with pleasure craft that operate primarily both in warmer weather and during daylight hours. Where barges are generally confined to a narrow channel in the river, pleasure boats range the full width of the river, and their speed and maneuverability allows them to steer clear of the barge tow's path. In addition, the barge industry has taken an active role in educating pleasure boaters on safely coexisting with commercial vessels through its Lifelines program. Barge transportation operates in a waterway environment that has few crossing junctures and is relatively remote from population centers -- all factors that tend to reduce both the number and severity of casualty incidents.

An independent modal safety study of transporting bulk hazardous substances prepared for the Maritime Administration, found that barge spills occur much less often than spills from either tank trucks or tank cars. 6/

Several theories help to explain relative spill frequency. The expected number of accidents is directly related to the number of modal units required to transport a certain amount of tonnage. Barges, because of their much larger capacity, require far fewer units than either rail or truck to move an equivalent amount of cargo, and therefore, have proportionately fewer accidents. Also, design features such as double-hulls, bolted flanges, automatic shutdowns, and various spill containment devices help

reduce the likelihood of a spill. In the early 1970s, one barge company began equipping its inland barges with six-inch guardrails to contain deck spills. This feature has proven so effective that the Coast Guard now requires it as standard equipment on all such barges.

Another factor that should further reduce the likelihood of spill incidents is recent legislation that requires new inland tank barges carrying liquid cargoes to be built with a double hull. The Oil Pollution Act of 1990 requires the phase-out of single-hull tank vessels carrying oil in bulk and prohibits operation of tank vessels less than 5,000, gross tons as of January 1, 2015. The inland tank barge industry is, and has been, well aware of the need to protect the environment, and has been moving in this direction for some time now. For example, over the last ten years (1984-1993), of the 271 inland tank barges built, only one was of single-hull construction! 7/

Perhaps the primary reason for the infrequency of barge spills is the existence of extensive training programs, and the documentation, licensing, and testing of all people involved in handling liquid products.

There is a difference of opinion as to whether it is safer to move hazardous cargoes in one big package or in many smaller ones. Is it safer to have a lo-barge tow of styrene passing under all the bridges that cross the Lower Mississippi or to have that same cargo carried by a 150-car train passing through downtown St. Louis? Most chemicals transported by water move in single 10,000 barrel barges that are mixed with dry cargo barges in the same tow. Most barge lines have rules that govern the placement of chemical barges in their tows; the more hazardous the chemical, the more strict the placement rules are. For example, a chlorine barge is always surrounded by dry cargo barges while a styrene barge might only be excluded from the corners of a tow. The point is, these barges can be protected in tows, an opportunity unavailable to rail and truck.

While arguments can be made for either opinion, on average, the environment of the waterway system places more room between it and the surrounding population/property than either rail or truck. Since the right-of-way for both rail and truck is narrower than that for the waterways, except for canals and locks, the potential for impact on people and property is usually greater for these other modes. Confirming this point, the study prepared for the Maritime Administration found that the relative human exposure index was higher for truck and substantially higher for rail than that for water. 8/

In the case of cargoes with special hazards that are shipped by water, the U.S. Coast Guard requires that only personnel who are fully licensed tankermen be allowed onboard tank barges, and that they have an understanding of the cargo's hazards. There are inherent risks in shipping by barge, but according to U.S. Coast Guard statistics, water transport is the safest and most regulated form of transportation and has fewer accidental spills or collisions than any other mode. This excellent record is directly attributable to both exacting operational safeguards imposed by the carriers themselves as well as strict federally-mandated inspection standards.

There is little public awareness of the water transport industry outside the river communities that it serves. This can be attributed primarily to the non-intrusive nature of the industry's operations and its impressive safety record. One of the primary reasons for this lack of intrusiveness is the width of most of the rivers, their location in relation to population centers, as well as levees and floodwalls.

CONGESTION

Most transportation infrastructure is supplied and managed by the public sector. For example, both the Federal Government and the states have long been involved with the regulation of road vehicle sizes (width and length) and weights because of the potential damage and safety costs associated with highway use by large vehicles.

Increasing congestion on America's highways and local urban streets continues to retard the nation's economic vitality. For some time now, traffic growth in the U.S. has far outstripped any increase in infrastructure capacity, and when traffic demand exceeds supply, congestion results, leading to delays and safety problems.

Above a certain threshold, traffic congestion has a number of negative impacts: it curtails the movement of people and goods, wastes valuable energy resources, increases personal trip times, impairs productivity, creates social tension, and damages the environment. As traffic congestion increases, the probability of accidents -- with attendant injuries and/or deaths -- also increases. Accidents and environmental damage tend to be most serious where heavy traffic either moves at high speed or is locked in congestion. Heavily traveled roads through towns and in built-up areas can lead to hazardous situations, restrict free movement, and disrupt community interaction.

Water transport has few congestion problems and seldom causes them for others. Waterway operators encounter little traffic other than pleasure boaters who steer clear of commercial traffic, and as a rule, each keeps to their 'own' area within the river.

The waterway industry has met the increases in additional cargo demand, not by building more towboats of the same size, but fewer ones with greater horsepower that are capable of pushing more barges at one time. The result is that fewer towboats are doing more work. Bigger tows are advantageous because they increase the capacity of the waterway system by reducing the total number of tows. Locks are used more efficiently because, up to the lock's capacity -- usually 15 barges --, a larger tow can lock through just as quickly.

This safe, quiet, virtually invisible transportation system has the unique capability to carry tremendous amounts of cargo. Except at lock structures that are either obsolete in size or operational aspects, the waterways have virtually no capacity restraints, and are far from being used to their full extent.

In Europe, some transport experts consider moving containers by inland waterway as the most effective and progressive system of transport, with virtually no limits on capacity and minimal environmental problems.

Like the waterways, rail, because it operates on a dedicated right-of-way, has no congestion problems of its own, but increased rail traffic, because of its sheer volume, can cause serious congestion problems for others (see LAND USE/SOCIAL IMPACT section). Congestion is much more of a problem for truck traffic, mainly because it does not operate on a dedicated right-of-way.

In addressing the best use of transportation assets, a consensus of opinion stated "To use the nation's resources most effectively, we must take better advantage of our transportation infrastructure and services. Many transportation facilities in the Nation could handle substantially increased traffic, including . . . many waterways .' 9/

AIR/NOISE POLLUTION

Years ago, the problem of air and noise pollution received scant public attention and aroused little public outcry. But as this situation became more critical, increased air and noise pollution levels have been considered an undesirable by-product of increasing industrialization, and the role of mobile sources in expanding air pollution has received new attention. Some of the most pervasive and intrusive air and noise problems result from the operation of certain transportation systems.

Noise levels have been rising due to increased traffic volumes, urban population growth, increased mobility, and the spread of mechanization. Transportation activity is, by far, the major source of noise, with road traffic the chief offender, even more so than aircraft noise. Air pollution caused by transportation includes both pollutants directly emitted by engines and secondary pollutants formed by chemical reaction in the atmosphere. Air pollution is caused by a wide variety of man-made and natural sources, with fuel combustion being the largest contributor. Again, road traffic is, by far, the dominant source of pollutant emissions.

A Corps of Engineers' study determined that commercial marine navigation, however, has a relatively minor effect on air quality. Air pollution resulting from water transport is far less than truck and is comparable to, or less than, rail, depending on such variables as terrain, route, etc.

The study further analyzed navigation emissions in the St. Louis region, a major hub of barge activity, shows that waterway traffic has less of an impact on air quality as compared to other transportation modes:

Annual Emissions For St. Louis Air Qualitv Control Region (In Tons)

Emission Source	Towboats	Other Transportation	Total Emissions
NOx	3,297	105,932	433,637
THC	939	198,063	295,124
co	2,101	980,944	3,852,753
sox	462	7,887	1,234,395
Part	198	8,940	354,672

NOx - Oxides of Nitrogen
THC - Hydrocarbons
co - Carbon Monoxide
sox - Oxides of Sulfur
Part - Particulates

SOURCE: ARMY ***CORPS OF ENGINEERS, NATIONAL WATERWAYS STUD?. 10/***

Another study by the Canadian National Railways shows that 1,000 pounds of diesel fuel produces 578 cubic feet of major pollutants, composed of: carbon-monoxide (CO)- 123 cubic feet, oxides of nitrogen (NOx)- 337 cubic feet, aldehydes (HCHO)- 12 cu. ft., sulfur dioxide (SOx)- 12 cu. ft., and hydro-carbons (HC)- 93 cu. ft. In transporting one million tons of cargo, diesel trucks would produce 26,500,000 cubic feet of emissions, rail 7,440,000 cubic feet, and water 5,600,000 cubic feet. These figures show that vessels produce 33 percent less pollutants than diesel trains and 373 percent less than diesel trucks. ll/

In a study prepared by the Environmental Protection Agency (EPA), the following air emissions readings were recorded by mode:

EMISSIONS PRODUCED
Pollutants (in pounds) produced in movinc one ton of cargo 1,000 miles

MODE	HYDROCARBON	CARBON MONOXIDE	NITROUS OXIDE
TOW BOAT	.09	20	.53
TRAIN	.46	:64	1.83
TRUCK	.63	1.90	10.17

SOURCE: ENVIRONMENTAL PROTECTION AGENCY, EMISSION CONTROL LAB

Water transport consumes much less energy per ton-mile of freight carried than either rail or truck. This factor, combined with the remoteness of the vessel's operating environment from population centers, substantially reduces the impact of its exhaust emissions.

Hydrocarbon vapor emissions from tank ships and barges while loading or unloading petroleum products amount to only about 0.02 percent of all volatile organic emissions nationally. Nevertheless, the U.S. Coast Guard has developed regulations for the use of vapor control systems to reduce these emissions, and the waterway industry is installing equipment to meet these requirements.

Protection of the marine environment from pollution is a major concern shared by the barge and towing industry with both Federal and State environmental agencies. The Coast Guard has law enforcement responsibilities relating to the protection of the marine environment, and many of its safety regulations for vessels have been enacted to serve this purpose.

Additionally, the Clean Air Act of 1990 requires installation of vapor recovery systems that will reduce emissions of petroleum and petrochemical vapors on barges designed to carry liquid cargoes -- a feature that is expected to cost the industry between $150 and $200 million.

Evaluation and control of transportation noise continues to be a significant issue for the industry. Under the Noise Control Act of 1972, EPA promulgated engine noise regulations for heavy trucks (over 10,000 pounds) involved in interstate commerce.

The Act also directed EPA to establish emission regulations for carriers engaged in interstate commerce by rail. Noise emission limits and regulations for locomotives and railroad cars have been issued by both EPA and the Federal Railroad Administration.

Little data exists on noise levels of barge operations, mainly because they are not considered a problem. A study by the Engineering Committee of the International Association of Great Lakes Ports calculated that vessels produced peak noises lower than either those produced by a truck operating under normal conditions or by a standing diesel locomotive. 12/

While transport systems generally have positive impacts on a country's economic life, they also have a negative side in terms of energy consumption, accidents, air, noise, and water pollution. However, the inland barge industry has made significant progress by reducing the negative impacts of these elements over the last two decades, and it is committed to reducing both vessel-generated noise and air pollution to an absolute minimum.

LAND USE/SOCIAL IMPACTS

While trucks and trains, to a degree, operate much closer to populated areas, barges quietly make their way along isolated waterways for most of their trip. The low-profile barge is one of the transportation industry's best kept secrets.

With some rail lines passing through major urban areas, the attendant noise impacts are experienced by nearby residents. Likewise, trucking operations commonly occur in or near high-density population areas that can be disturbing to an otherwise reasonably tranquil environment. By contrast, river barges, for the most part, have little impact on densely-populated areas. Barge transits are relatively infrequent because of the large tonnage moved at one time. River operations take place in channels away from the shore, and the engines of a towboat are usually below the water line, which muffles the sound. In addition, levees and seawalls also shield residents from towboat noise in the same manner as highway sound barriers do.

Surface traffic, both road and rail, near residential neighborhoods contributes to visual, physical, and psychological barriers that can lead to the fragmentation of those neighborhoods. Reduced social interaction, reduced access to other neighborhoods, and increased traffic congestion and/or changes in traffic patterns are often a result of increased surface traffic. Traffic congestion can lead to serious disruptions of police, fire, and medical services, as well as periodic isolation of parts of communities.

Since most of the right-of-way for water transport is provided by nature, navigation is less likely than the other transport modes to be competing with non-transportation uses for land area, especially in urban locations. Concerning new land acquisition, commercial waterway activity preempts very little land.

What is true here in America is also applicable in other parts of the world, especially where the population density is greater. Nowhere is this more critical than in Western Europe where land use is at a premium. Transportation experts there have recognized that Europe must promote environmentally friendly transport modes, and that land modes probably should be taxed more heavily than shipping or the railways in order to encourage a shift to more environmentally compatible forms of transport.

After an exhaustive study of transportation policy and the environment, a report has been issued by the European Conference of Ministers of Transport (ECMT) that, among other things, recommended that the member countries consider switching freight from road transport to more environmentally friendly modes and increase the use of inland waterways. 13/ This recommendation coincides with the fact that environmental concerns are prompting more European companies to use rail and inland waterways instead of road transport, and some European chemical companies are making greater use of the waterways because of their concern for safety. These are some examples that reflect present environmental concerns in Europe and the current feeling there about water transportation.

A recent study of transport impacts on the environment was done for the twelve European countries that make up the European Community. It compared, by mode, the social costs of air and noise pollution, land coverage, construction/maintenance, and accidents (see Table 1). For all five categories, water transport had the least environmental impacts. In three of the categories, viz, noise pollution, accidents, and land coverage, water transport had little or no impact. As a result of this study, there is a growing demand by the member countries that inland navigation should be included in international traffic management since it is far less detrimental to the environment than shipping by road.

ENVIRONMENTAL ASPECTS

Much of the nation's freight is moved intermodally, i.e., by more than one transportation mode. The water mode is the link in this transport chain that usually receives the least publicity -- which is unfortunate considering the significant contribution made by waterborne commerce to the economy of the nation.

This is also true for many countries that have major river systems. These countries realize that their inland waterways are a valuable natural resource, and, consequently, they are aware of the savings that investment in waterborne transport can bring. The benefits to be derived from improving their waterways are significant for both the developed and the less-developed nations, but the latter may well see the investment of their scarce funds in waterway development as one of the quickest ways to help build their indigenous industries and to make the 'great leap forward'.

The environmental impacts of water transportation vary from river to river and project to project, but in many cases, the environment is not noticeably affected by waterway freight transport. Where it does have a negative impact, the effect is usually minimal.

Because of the concern over the impacts that the different transportation modes have on the environment, there has been a more concerted effort to identify those impacts. Therefore, during the last two years, three studies 14/ that are similar in nature analyzed the types and levels of impacts of a modal shift on the environment; viz. what happens if cargo movements are shifted from one mode to another. Specifically, what would be the increases in fuel usage, exhaust emissions, probable accidents, traffic congestion, etc. All three studies compared the same cargoes shipped by different modes, and concluded that, ton for ton, vessels have fewer accidents, consume less energy, produce fewer harmful emissions, and are less disruptive to society in general. These studies' findings show that transporting bulk commodities by water is environmentally compatible, provides a means to sustainable development, and that the use of this environmentally-friendly mode should be encouraged.

There have been other studies that have examined water transport's impact on the waterway environment. A report released by the Illinois State Water Survey in 1993 found that current levels of barge traffic on the Illinois River are not adversely affecting water quality in the navigation channel. This conclusion was reached after "one of the most ambitious sample collection regimens ever, in combination with rigorous

laboratory and quantitative analysis." In fact, the researchers found "that natural phenomena influenced water quality to a far greater extent than commercial barge traffic." 15/

A 1988 study - and a 1993 update - of tank barge movements on the Upper Mississippi River, prepared by the Minnesota Department of Transportation, show that barges are responsible for fewer and smaller river spills than other modes or fixed facilities, and pose little threat to the riverine environment in Minnesota. Spills from commercial navigation activities accounted for only 1/2 of 1 percent of the total spills into the river. During the five-year (1988-1992) study period, the towing industry handled 4.9 billion gallons of liquid cargo; the amount spilled represents .0007 of 1 percent of what was handled.

All of the studies cited above have reached the same conclusion: that transporting liquid cargo by water has been and continues to be the safest of the transportation options. 16/

In addition to the many advantages of commercial freight transportation, there are a number of coincidental benefits related to water transportation. Other major beneficiaries include recreation, wildlife habitat, flood control, public water supply, irrigation, industrial use, and economic development. With regard to this last factor, water transport, in some rural sections of the country, has played a major role in generating economic activity, employment, and income. Frequently, the benefits resulting from these other purposes are as important as the waterway itself.

One specific benefit of waterways is that they can interact with nature as a good environmental neighbor. For example, in the process of building waterway projects, e.g. a new lock and dam, provisions are made to preserve, enhance, and create wetland and aquatic habitats. National wildlife refuges and designated areas along the rivers are home to many species of fish and wildlife, and are used by millions of migratory and resident birds. To cite just one example, a marshland was created using disposable material from a dredged channel that has become a winter home for some of the world's remaining 142 whooping cranes on Aransas National Wildlife Refuge in Texas. With minimal ecological impact and unique environmental compatibility, water transport is considered by many to be the most environmentally friendly form of surface transportation.

In a 1992 National Geographic article describing the opening of the Main-Danube canal in Germany, the manager for the project was quoted as saying, "Transporting bulk goods by water is cheaper, cleaner, and more energy efficient than by any other means."

The article also cites a number of favorable impacts from the canal: acting as an economic spur to the region; providing flood control; allowing the transfer of water from one area where supplies are plentiful to another that is water-poor; diluting pollution in the Main River by pumping in cleaner water from the Danube; and providing recreational opportunities both along the canal and on several new artificial lakes. All of these impacts can be viewed as incidental benefits that are in many ways as important as the canal itself. 17/

CONCLUSION

There is a growing national commitment to the restoration and preservation of our environment, including the conservation of natural resources and a focus on better land uses. As part of this commitment, one of today's primary concerns is the extent to which the environment can absorb our generated wastes.

The companies that make up the barge and towing industry have a reputation for a strong environmental stewardship and are dedicated to improving the compatibility of their operations with the environment in an effort to eliminate environmental incidents and reduce environmental hazards to an absolute minimum. This commitment is evidenced by the following fundamental principles that these operators have established:

-- Make environmental protection a priority in business planning.

-- Maintain active and effective environmental policies and programs designed to protect the environment.

-- Conduct business and operate and maintain vessels and facilities in a manner that protects the environment, as well as the safety of its employees and the public.

-- Develop and implement company programs that address education, training, and communications of environmental policies and procedures. Emphasis will be placed on the importance of strict compliance with federal, state, and local laws and regulations regarding marine safety and the environment.

-- Maintain and update emergency response plans that allow the companies to respond swiftly to environmental incidents and minimize environmental damage.

-- Actively participate with government and other interested parties in creating responsible laws, regulations, and programs that safeguard the environment.

-- Seek out and respond to proposed environmental, matters or concerns from either public or private sectors.

-- Strive to reduce vessel-generated waste and emissions by improving operating procedures.

- Work in partnership with manufacturers shippers, and vendors to enhance safe transportation of products and the management of cargo residues and cleaning wastes associated with the transportation of cargoes.

Pollution control, protection and enhancement of the environment, and maintenance of the ecological balance have long been major concerns of the waterway industry. Barge operators adopted the position years ago that it favored, supported, and would aggressively work to prevent and control its share of pollution even though authorities agree that its portion is negligible. The industry is constantly reinforcing that commitment.

ENDNOTES

1. Eastman, S.E., ***Fuel Efficiencv in Freiuht Transportation,*** The American Waterway Operators, Inc., Arlington, VA, June, 1980, p.7.

2. MOOZ, W.E., ***The Effect of Fuel Price Increases on Energy Intensiveness of Freight Transport,*** Rand Corporation, Santa Monica, CA, December 1971.

3. National Waterways Foundation, U.S. ***Waterways Productivitv, A Private and Public Partnership,*** Huntsville, AL, 1983, **PP* 165-167.**

4. Robert J. Blackwell, Assistant Secretary for Maritime Affairs, U.S. Department of Commerce, Personal Correspondence, to Philip Carroll, Director, Energy Conservation Division, U.S. Department of Commerce, undated.

5. National Waterways Foundation, U.S. ***Waterwavs Productivitv,*** p. **84.**

6. U.S. Department of Commerce, Maritime Administration, ***A Modal Economic and Safetv Analvsis of the Transportation of Hazardous Materials In Bulk,*** Cambridge, MA, July 1974, p.9.

7. Lambert Jack, ***Barge Fleet Profile of Inland River Equipment,*** St. Paul, MN, March 1994, pp. 11-12.

8. Maritime Administration, Op. Cit., p.9.

9. ***U.S. Department of Transportation, Moving America, New Directions, New Opportunities, A Statement of National Transportation Policy,*** Washington, DC, February 1990, p.46.

10. U.S. Army Corps of Engineers, Institute for Water Resources, Water Resources Support Center, ***National Waterways Study: Analysis of Environmental Aspects of Waterway Navigation, Review Draft,*** Fort Belvoir, VA, April 1980, p* 227.

11. International Association of Great Lakes Ports, Report of the Engineering Committee, ***The St. Lawrence Seaway: The Quiet, Efficient Marine Highway,*** Toronto, Ont, June 22, 1972; p.5.

12. Ibid., p.4.

13. Organization for Economic Co-operation and Development (OECD), European Conference of Ministers of Transport, ***Transport Policy and the Environment,*** Paris, France, 1990, p. 99.

14. Minnesota Department of Transportation, ***Environmental Impacts Of A Modal Shift*** St. Paul, MN, June 1992; A. K. Socio-Technical Consultants, ***Environmental Efficiency of Marine Transportation,*** Ottawa, Canada, January, 1993; Great Lakes Commission, ***Great Lakes and St. Lawrence River Commerce: Safety, Energy and Environmental Implications of Modal Shifts,*** Ann Arbor, MI, June, 1993.

15. Illinois State Water Survey, Department of Energy and Natural Resources, ***Impacts of Commercial Navigation on Water Quality in the Illinois River Channel,*** Champaign, IL, 1992.

16. Minnesota Department of Transportation, ***Liquid Carao Movements on the Minnesota Portion of the Upper Mississippi River,*** St. Paul, MN, June 1988; March 1993 (updated).

17. National Geographic Society, ***National Geographic, Vol. 182, No. 2,*** Washington, DC, August 1992, p. 15-16.